Issued June 10, 1912.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 494.

# LAWN SOILS AND LAWNS.

BY

OSWALD SCHREINER, *Soil Scientist*, AND J. J. SKINNER,
*Soil Scientist, Bureau of Soils*,

AND

L. C. CORBETT, *Horticulturist*, AND F. L. MULFORD,
*Landscape Gardener, Bureau of Plant Industry.*


WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

# LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
*Washington, D. C., August, 1911.*

SIR: We have the honor to transmit and to recommend for publication as a farmers' bulletin the accompanying paper on "Lawn Soils and Lawns," by Dr. Oswald Schreiner and Mr. J. J. Skinner, of the Bureau of Soils, and Prof. L. C. Corbett and Mr. F. L. Mulford, of the Bureau of Plant Industry.

The widespread movement of civic art to improve and beautify cities and towns by park and art commissions, civic associations, and individuals creates a demand for information concerning lawns, their improvement, soil requirements, fertilization, maintenance, soil suited for filling-in or top dressing, and similar questions. It is to supply this general demand for information regarding lawns and lawn soils that the present bulletin is designed.

Respectfully,

MILTON WHITNEY,
*Chief, Bureau of Soils.*
B. T. GALLOWAY,
*Chief, Bureau of Plant Industry.*

Hon. JAMES WILSON,
*Secretary of Agriculture.*

# CONTENTS.


| | Page. |
|---|---|
| Introduction | 5 |
| General characteristics of lawns | 5 |
| The soil | 6 |
| Essential characters | 6 |
| Adaptability of soils of different texture for lawns | 6 |
| Heavy or clayey soils | 7 |
| Sandy soils | 8 |
| Influence of subsoil on lawns | 9 |
| Characteristics of a good subsoil | 11 |
| Importance of soil moisture | 11 |
| Movements of water in soils of different texture | 12 |
| Influence of building débris | 13 |
| Good drainage necessary in lawn soils | 14 |
| Organic matter necessary to make a good lawn soil | 15 |
| Effect of organic material in lawn soils | 15 |
| Other factors which affect lawns | 16 |
| Soil building for lawns, parks, parked embankments, and terraces | 17 |
| Proper and improper filling-in of subsoil material | 17 |
| Hauling in of productive surface soil | 18 |
| Selection of soil best suited for grass growing | 19 |
| The ideal soil | 21 |
| Grading soils for lawns | 21 |
| Preventing erosion on terrace banks | 23 |
| Tile drains in lawn soils | 23 |
| Preparation of the soil | 25 |
| Fertilizers | 26 |
| Grasses adapted to lawn making | 27 |
| For sunny areas | 28 |
| For shady places | 33 |
| For terraces and terrace banks | 34 |
| Other ground covers | 35 |
| Seed | 36 |
| Establishing a lawn | 39 |
| Sodding | 40 |
| When to plant a lawn | 41 |
| Maintenance of a lawn | 43 |
| Weeds | 43 |
| Fertilizers | 44 |
| Liming | 46 |
| Relation of walks and drives to the greensward | 46 |
| Relation of trees and shrubs to a lawn | 47 |
| Botanical names of grasses referred to in this bulletin | 48 |
| Botanical names of plants other than grasses referred to in this bulletin | 48 |

# ILLUSTRATIONS.


| | | Page. |
|---|---|---|
| Fig. 1. | Soil auger | 9 |
| 2. | Three-foot profiles of soils | 10 |
| 3. | Building débris in lawn soils | 13 |
| 4. | Careless laying of soil on improperly prepared soil | 14 |
| 5. | Faulty soil building on public grounds | 18 |
| 6. | Proper and improper soil grading | 22 |
| 7. | An eroded terrace bank | 23 |
| 8. | Harrow for soil preparation | 25 |
| 9. | Cowpeas as a soil improver in making lawns | 26 |
| 10. | A good bluegrass lawn | 28 |
| 11. | A typical bluegrass and white-clover lawn | 29 |
| 12. | A mixed-grass lawn | 30 |
| 13. | Bermuda grass in a bluegrass lawn | 32 |
| 14. | Cross section of improper and proper lawn grading | 35 |
| 15. | A bank covered with moneywort | 36 |
| 16. | A bank better than the avorage on slopes | 37 |
| 17. | An ivy-covered bank | 38 |
| 18. | Implement used for cutting sod | 41 |
| 19. | Crabgrass in a neglected lawn | 44 |

# LAWN SOILS AND LAWNS.

## INTRODUCTION.

The greensward is the canvas upon which all architectural and landscape effects are produced. A lawn may vary in extent from a few square feet at the side of the steps leading to the brownstone front of the city dwelling to the broad acres of extensive parks. It matters little whether the extent of a lawn be great or small, its inherent qualities are the same, and its intrinsic worth is determined by its character and the manner in which it is kept. Green grass is not only of great economic value, but it is also of great esthetic value. The herbage of the field is the primary dependence of all animal life, and it is the green color, the sweet fragrance, and the soothing effect of nature which come from well-kept greenswards that make them so congenial to man. Grass is nature's balm and healing for all erosive scars. Nature abhors rough edges and broken places, and immediately proceeds to cover such ugly spots with green grass. Man likes to get his feet upon the soil, but, better still, upon the soft, yielding greensward. Rich rugs and carpets do not give the elastic spring that the well-made and well-kept greensward yields.

A lawn is the accompaniment of every effort on the part of man to beautify the surroundings of his abiding place. The great increase of interest in suburban and rural life has caused a corresponding increase of interest in matters pertaining to the making and maintenance of lawns. Suburban railways, the extension of electric lines into the country, and the return of man to natural ways of living are all factors contributing to the growing interest in matters pertaining to lawn making.

## GENERAL CHARACTERISTICS OF LAWNS.

In general, a lawn should be beautiful and it should be useful. Its beauty depends upon the contour of the land, the color and texture of the grass, and the uniformity of the turf. The use of the lawn is to provide a suitable setting for architectural adornment and landscape planting. Every device should be employed when working with small areas of ground to give the lawn as great extent as possible. The buildings should be well back, the foundation not too high, and the grading of the ground should be slightly convex—that is, a gently

convex, rolling surface from the base of the foundation to the street line, rather than concave. A convex surface tends to give the effect of increased area, while a concave surface seemingly shortens the distance. The extent of a lawn is also amplified by preserving as large areas of unbroken greensward as possible. This means the use of trees and shrubs only upon borders or margins of the lawn, rather than a promiscuous dotting of them over the greensward.

## THE SOIL.

The ideal soil for a lawn is available in but few cases where it is desirable to establish a greensward. Ordinarily the lawn in which a man is most interested is that immediately surrounding his abiding place. The soil of this immediate locality is, in general, greatly modified because of building operations or necessary grading. The soil with which one has to deal, therefore, is seldom a normal soil of the locality. In general, it is a portion of the surface soil mixed with more or less of the subsoil which has come from excavation in making the foundations of a house. Large lawns and parks are not, as a rule, so subject to difficulties of this kind as are small private grounds. The problem before us, then, is that of converting not a normal but an abnormal soil into a suitable and congenial place for the growing of grasses.

## ESSENTIAL CHARACTERS.

A lawn soil should have a good moisture supply at all times. It should be able to take care of excess during the wet season by drainage and during the dry season be able to supply stored-up moisture from its depths. This adequate water supply is the principal factor in grass growth and the one most difficult to control in a poor soil. It is more important than any added fertilizer and can not be compensated for by the addition of any amount or kind of chemical plant food. All suggestions regarding lawn soils, their texture, selection, and manipulation have been made with one end in view—the creating and maintaining of an adequate water supply in as natural a manner as possible. If this water supply is maintained effectually by a normal soil, the natural processes which go hand in hand with it, such as proper bacterial activity, aeration and oxidation, soil sanitation, and the supply of plant food generally, are also sufficient for a healthy growth of a good greensward.

## ADAPTABILITY OF SOILS OF DIFFERENT TEXTURE FOR LAWNS.

The soil material consists of several recognizable grades, which can be determined in any given soil by analysis—clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel. It is this

difference in the size of soil particles and in the proportions in which they are present in soils that has given rise to the different classes of agricultural soils, such as the clays, clay loams, sands, and sandy loams. This difference determines the texture of the soil. The texture is a particularly important factor in a successful lawn, as it has a very marked influence on the kind of grass or combination of grasses and clovers best suited to the soil; on its ability to hold sufficient moisture to carry the grass through a prolonged drought; on the ease of establishing good natural drainage; on the amount of aeration, and on other requirements. The various percentage relationships of these different grades determine the texture of the soil and the class to which it belongs; that is, they determine whether it is a sand, a loam, or a clay, or an intermediate soil class.

These soil classes fall naturally into two divisions, the heavier and the lighter soils. The heavier soil classes contain comparatively large amounts of the two finer grades of soil material—silt and clay. The lighter soils contain a large percentage of the sand grains, especially the finer sands. In other words, in the heavier soils are found large amounts of silt and clay particles, with vanishingly small amounts of the more sandy grains; in the lighter soils are found large amounts of the sandy grains, with vanishingly small amounts of silt and clay on the one hand and the coarser grades on the other.

The following discussion of different soil classes will be useful as a guide in selecting soils suitable for lawn or park purposes and for the production of lawn soils by proper mixing of two or more soils of different texture.

## HEAVY OR CLAYEY SOILS.

**Clay soils.**—When productive these soils usually make very strong lawn soils, giving a dense sod In the regions suited to the Kentucky blue grass, excellent lawns consisting wholly of this most desirable of lawn grasses are easily obtained. The clay soils are usually, however, more difficult to prepare for lawn purposes, as the handling of the soil requires greater care than the more loamy soils to obtain a good physical condition at the time the seed is started. Liming is often desirable to help loosen the texture, and the plentiful incorporation of organic manure is almost a necessity. In very heavy clays it will often prove advantageous to incorporate a loam or sandy loam with the first few inches.

**Clay loam soils.**—When well drained and carefully handled, a clay loam is well suited for the establishment of an excellent greensward. It is retentive of moisture in amounts decidedly favorable to a good growth of grass. In the making of lawn soils by mixing, clay loams give good results, especially for mixing with sandy soils.

**Silt loam soils.**—These soils are ideally adapted to lawn making, but they must have good drainage and be liberally supplied with organic matter.

**Loam soils.**—These soils, when they have good drainage and contain sufficient organic matter, will maintain a good lawn. When hauled in, due consideration should be given to the nature of the soil or filling already in place, as this becomes the subsoil of the finished lawn.

TABLE 1.—*Average composition of soil materials, showing the proportions of the different-sized particles.*

[Mm.=millimeters.]

| Soil classes. | Percentage composition. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fine gravel 2–1 mm. | Coarse sand 1–.5 mm. | Medium sand .5–.25 mm. | Fine sand .25–.1 mm. | Very fine sand .1–.05 mm. | Silt .05–.005 mm. | Clay .005–0 mm. |
| Clays | 1 | 3 | 2 | 8 | 8 | 36 | 42 |
| Clay loams | 1 | 4 | 4 | 14 | 13 | 38 | 26 |
| Silt loams | 1 | 2 | 1 | 5 | 11 | 65 | 15 |
| Loams | 2 | 5 | 5 | 15 | 17 | 40 | 16 |
| Fine sandy loams | 1 | 3 | 4 | 32 | 24 | 24 | 12 |
| Sandy loams | 4 | 13 | 12 | 25 | 13 | 21 | 12 |
| Fine sands | 1 | 4 | 10 | 57 | 17 | 7 | 4 |

## SANDY SOILS.

**Coarse sandy soils.**—These soils are unsuitable for lawn purposes. Although certain grasses will grow upon them, and where necessary can be used as soil binders, the result produced can hardly be called ornamental. They are too dry and loose for lawn purposes.

**Fine sandy soils.**—A fair lawn may be established on soils of this class by paying special attention to the preparation of the soil by the introduction of manure or green manure, together with bone phosphates, and lime in some cases, and copious watering during dry seasons. With a clay or clayey subsoil a really good and permanent lawn can be established on such sandy soils without great difficulty, especially when a mixture of suitable grasses is used. Its low water-holding power is its chief drawback. Top dressings of well-rotted stable manure and other fertilizers from time to time are requisite for good results. Lime as a top dressing is also often desirable on sandy soils.

**Sandy loam soils.**—Such soils make very good lawns when well drained and well supplied with organic matter; and, where underlain by a clay or sandy clay subsoil, they sometimes even rival the clay loam or silt loam in adaptability to lawn grasses. When low in organic matter the deficiency must be made up. Stable manure, forest

mold, green crops plowed under, especially the legumes, afford very desirable materials for supplying organic matter. Lime is frequently desirable and often necessary in the soil preparation and as a later top dressing. Bone phosphate should be used in preparing the soil and may be later used as a top dressing.

**Fine sandy loams.**—These are very similar to sandy loam soils in their adaptability to lawn making and have even a greater water-holding power.

## THE INFLUENCE OF SUBSOIL ON LAWNS.

Soils are underlain at different depths in different types by a distinctly different soil layer known as the subsoil. In shallow soils this subsoil, usually of a different texture, but not necessarily so, is sometimes within a few inches of the surface, and is indeed often touched by plow or spade, and thus gradually the soil itself may be deepened and changed in texture. In other cases the soil is quite deep, often many feet, and in arid regions this change in soil material as one goes downward is often not observable at all.

FIG. 1.—Soil auger for collecting soil samples and useful in exploring subsoil conditions in lawns. Such an instrument entirely prevents the disfigurement which would be unavoidable if a larger hole had to be dug in a lawn.

A soil can not be judged for lawn purposes simply by the visible surface or top soil as far as it is ordinarily cultivated or turned by plow or spade. The depth of the surface soil is very important and variable. Soils of widely different agricultural value owe this often to difference of depth alone. The fact that the nature of the subsoil has an effect on the productiveness and suitability of soil for lawn purposes has already been mentioned. Those soils having a clay subsoil are usually stronger soils and better able to maintain a good lawn than those having sandy subsoils. In the sandy soils the better results are always obtained where a good clayey or even clay subsoil occurs.

In figure 2 are shown 3-foot profiles of soil types illustrating different depths of surface soil and nature of subsoils as actually encountered under natural conditions.

The texture of the subsoil is fully as important as the texture of the soil, although the requirements of a good subsoil are usually somewhat different from the requirements of a good top soil. An impervious clay subsoil is utterly unsuited for any crop, and soils occurring

above such subsoils are themselves usually poor, but can often be made most productive by laying drainage tiles in the subsoil. The character of the subsoil, its texture, and its distance from the surface

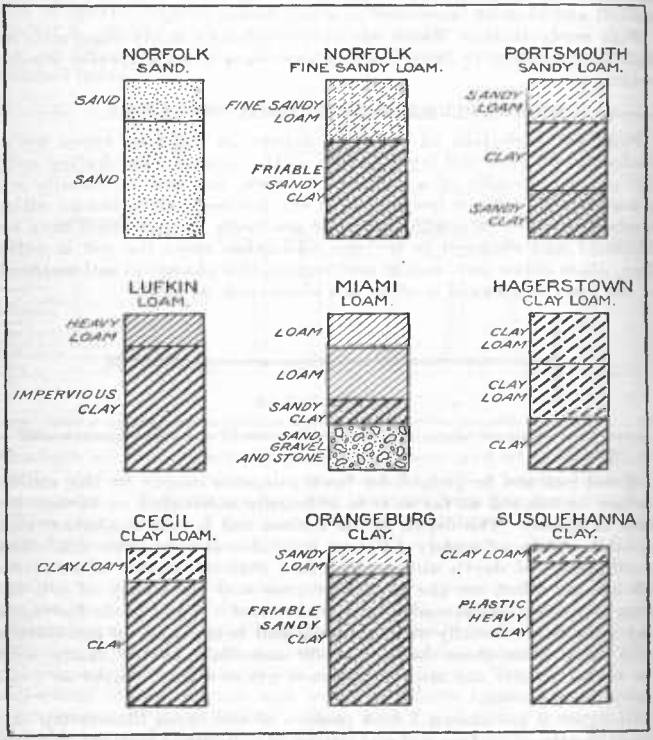


FIG. 2.—Three-foot profiles of soils, illustrating different depths of surface soil and nature of subsoils.

are often vital criterions of the natural productiveness and suitability of soils, and hence these factors must also receive consideration in the establishing of a lawn, whether it be by filling in of soil materials or on a soil in its natural position.

## CHARACTERISTICS OF A GOOD SUBSOIL.

In the first place the subsoil of a good lawn soil should not be too near the surface; that is, the soil itself should be a deep soil, never less than 6 inches and preferably as deep as 12 inches or more, for it must be remembered that a good subsoil, even when good as a subsoil, is nevertheless a poor substitute for a surface soil.

There is no doubt that in certain sections of the country some subsoils are harmful when incorporated in a soil, and that while deep plowing is desirable, it is unsafe, after shallow plowing has been carried on for years, to run the plow down and turn up a great mass of subsoil and incorporate this with the soil. In a great many cases it has taken several years to restore the original fertility of the soil. A subsoil should never be used in lawn building without being covered 6 to 12 inches with a good surface soil. The subsoil should resemble the surface soil in its general character. It should be heavier in texture when underlying sandy soils. The subsoil should be moist at all times, yet permit of good drainage. It should contain considerable amounts of water during the wet season, and later, during dry spells, be able to give it up to the surface soil and roots therein. By virtue of a close and firm texture it can draw moisture from a considerable depth. If the subsoil is of bad texture, such as impervious clay, the drainage is bad and the soil consequently cold and wet, unmanageable, and unproductive, or if it consists of a loose sandy material it will be too leachy and consequently too dry, especially during droughts, because no water will be stored in it or drawn up through it from greater depths.

Other bad soil conditions, involving bad drainage, are various hardpan formations. These are usually layers of soil cemented together by lime or iron compounds and are found in some regions in large sheets or pockets, often immediately below the surface soil, thus acting as an effectual barrier to the movement of moisture, either downward or upward. Under such conditions, which are fortunately rare in soils to be used for lawns, grass can not be grown any more than on a cement or other sidewalk buried a few inches under ground.

## IMPORTANCE OF SOIL MOISTURE.

The growing grass obtains the products of solution of the soil materials, inorganic and organic, both good and bad, through the medium of the soil fluid. From the soil fluid it obtains the potassium, calcium, magnesium, phosphorus, nitrogen, and other elements necessary for its nutrition. These it removes from the soil fluid by the process of absorption by the growing root, and when the soil sanita-

tion is good this absorption proceeds in a normal manner, but when it is imperfect, due to bad drainage or accumulation of products unfavorable to growth, the absorption of the plant is seriously interfered with. Most important, however, is the water of the soil fluid itself, for this is absolutely necessary for grass growth. It is the plant's chief source of hydrogen and oxygen, which, together with carbon obtained from carbon dioxide of the air, forms the larger part of the plant's total dry substance. The water, moreover, forms the larger part of the grass itself when green. This fact tends to emphasize the great importance of soil fluid to the growing grass and further shows the absolute dependence on it for establishing a good growth of grass. The importance of the soil condition and texture in influencing the amount and movement of this soil fluid becomes, therefore, of paramount interest, as through it the life of the lawn is sustained and maintained.

The greatest drawback to the establishing of a good lawn is an inadequate water supply during periods of drought, and the chief function of a good lawn soil is to furnish an adequate water supply—to moderate excessive rainfall by good drainage and yet hold sufficient water to allow the lawn to live through periods of drought. The roots of lawn grasses are comparatively close to the surface, not penetrating more than a few inches into the soil except where excellent soil conditions exist. The greater the depth of surface soil the deeper will the roots penetrate and consequently the greater the amount of soil fluid directly available. Ordinarily, however, the soil accessible to the roots will, even in a soil with good water-holding power, not contain sufficient water to last through a considerable drought, and it is therefore necessary that the soil be able to draw moisture from lower lying strata. A heavy retentive subsoil acts as a soil reservoir to supply the surface soil with water during dry spells.

## MOVEMENTS OF WATER IN SOILS OF DIFFERENT TEXTURE.

The movements of soil fluid are chiefly upward and downward, any lateral movement being extremely slight. The downward movement occurs as a result of rainfall, melting snow, or other addition of water to the surface. This downward movement is usually rapid and varies according to the texture and structure of the soil, which also determines the amount of water retained in the soil. Later, by evaporation from the soil or through transpiration by the grass, this moisture in the soil is gradually dissipated into the atmosphere and a movement of soil fluid is set up within the soil whereby moisture moves from the wet subsoil into the surface soil through the capillary spaces made by the soil grains or aggregates of grains. In loose, sandy soils the moisture descends rapidly, reaches the water level below

the soil and subsoil, and begins its movement laterally from the soil as seepage water, finding outlets into ditches, streams, and other watercourses, comparatively little being retained in the moisture films around the sand grains. During dry periods this retained moisture is soon depleted, and owing to the coarseness of the grains the movement upward is not sufficient to keep up with the demand in the surface soil, the connection with the subterranean water is broken, and a dry subsoil is the result, thus causing an impoverishing of the lawn, with ultimate parching and drying out of the grass during the summer months.

In the heavier soils the water does not descend so rapidly nor so completely. Considerable amounts are retained and, when required, move upward to the surface soil. Moreover, the connection between the soil fluid and the low-lying water level is not so easily severed, so

FIG. 3.—Building débris in lawn soil. The presence of bricks, flat tins, boards, and other coarse building débris, found in nearly all small lawns in the cities, is very detrimental to the proper movement of soil fluids.

that water from considerable depths can be drawn upon to supply the needs of the surface soil.

## INFLUENCE OF BUILDING DÉBRIS.

Bricks, flat tins, boards, and other coarse building débris found in nearly all small lawns in the city are very detrimental to the proper movement of soil fluid. The downward movement of water is not seriously impeded by such materials and is probably even facilitated. The moisture moves downward until it encounters a brick, for instance, at a distance of 3 or 4 inches below the soil level. The water meets with no difficulty in getting to the edge of the brick and then goes nearly straight downward, thus leaving the soil immediately below the brick unsupplied from this new water influx. Now, when

the opposite movement of soil fluid begins the water moves upward until it encounters the brick, and the soil immediately above the brick, which has in the meantime dried out, remains unsupplied with moisture, so that the grass suffers and dies out during a critical dry spell. Bad spots in small city lawns are more often than not found to be due to some such impediment to the movement of capillary water.

## GOOD DRAINAGE NECESSARY IN LAWN SOILS.

The beneficial property of the heavier soils and subsoils which enable them to retain moisture and offer resistance to its free passage presents, on the other hand, a danger. When this resistance, by virtue of too close a texture or lack of structure, becomes excessive the soil

FIG. 4.—Careless laying of sod on improperly prepared soil. The débris is almost as great as the actual sod material, and either through ignorance, indifference, or carelessness this débris is covered over with, at best, indifferent sod, with only one possible result, a poor lawn.

becomes, as it were, "waterlogged," producing a wet, cold soil, without aeration and proper life. There is an almost total arrest of the normal functions of the soil and a substituting therefor of an abnormal condition, resulting in the formation of compounds inimical to the growth of grass, so that it dies from the presence of harmful compounds or poor air supply at the roots. Such a condition can be helped or eliminated by proper drainage, such as may be secured by the laying of tiles in the subsoil, whereby the flow of water is facilitated, the air again penetrating, and a normal oxidation and functioning of the soil are brought about. The application of lime aids in forming the clay particles into larger groups, thus giving large spaces between these groups, through which the soil fluid can move with greater freedom. This is often resorted to, and should never be omitted in making lawns on soils having very stiff subsoils. Hardpan

formations and other natural hindrances to the movement of water must also be broken up by subsoiling or other means, as good drainage, like a good water supply, is absolutely essential for a healthy greensward.

## ORGANIC MATTER NECESSARY TO MAKE A GOOD LAWN SOIL.

The organic matter is the great promoter of proper structure of the particles to form an arable soil; its influence in the formation of loamy friable soils of good texture and structure is well known. The organic materials of the soil are very important, in that they make soil out of what would otherwise be only a rock powder or sand. By its presence and the changes which take place during its decay the water-holding power of a soil is greatly increased, and hence its presence in lawn soils is especially desirable. It is, however, in the lawn that it is most difficult to introduce organic matter into the soil, and it becomes imperative, therefore, that the lawn soil be made as rich in this important soil ingredient as possible before planting, i. e., when the lawn soil is first prepared. Later, when the lawn is established, organic matter can only be introduced into the soil in the soluble material leached from manure and other surface applications, and the beneficial effects in loosening up soils produced by the decay of the insoluble materials of the manure are, therefore, entirely absent. The decay of manure is usually more rapid in sandy soils than in clay soils, another factor which makes the sandy soils less desirable for lawns.

## EFFECT OF ORGANIC MATERIAL IN LAWN SOILS.

The organic materials have a chemical and physiological effect on the lower life in the soil as well as on the grass. In addition to the physical effects already noted, some of the products of change of these organic materials are doubtless directly beneficial to bacteria, promoting their activities, and also directly beneficial to the growing grass. It is likewise certain that some organic soil constituents are directly harmful to grass, preventing its best development, interfering with its root growth and root absorption of soil nutrients to such an extent as to make the successful growth of grass under such conditions impossible.

The application of good organic manures, liming, and drainage are the most potent factors in promoting good soil conditions. Liming has been found to be very beneficial, aiding the destruction of harmful bodies of this nature, both by combining with them and also by oxidizing them to other less harmful, or even beneficial, compounds. Drainage also aids materially in two ways: First, it allows a freer access of air with deeper penetration of healthy roots, which in time promotes oxidation, and thus aids the destruction of unfavorable

organic matter; second, it will produce beneficial results by an actual removal of the harmful material in the drainage waters, as well as by eliminating the cause of its formation. The addition of good organic manures will also assist in the destruction of the injurious compounds already in the soil. The introduction of easily decomposed organic matter causes greater bacterial activity and greater oxidation in the soil. The fertilizer salts likewise induce or quicken changes which take place without them only very slowly or not at all.

## OTHER FACTORS WHICH AFFECT LAWNS.

It is not possible to state definitely to what extent root excretions may affect lawns, but this much is certain: Plants or soils are affected as the result of the continuous growth of the same plant or by the simultaneous growth of two or more plants. The influence of certain trees or shrubs on the lawn may be, in part at least, ascribed to such a cause. If the excreta of grass itself affects the continuous growth of grass, it is also certain that this effect would show itself more on certain soils than on others, and on a soil suited admirably for the development of grass such an effect would be entirely eliminated, for the good soil conditions would be able to destroy the unfavorable material from season to season and thus prevent an accumulation which would take place in the course of time under less favored soil conditions. The association of different grasses and clovers would no doubt aid in prolonging the natural life of a lawn under conditions which would cause the early decadence of a lawn sown to only a single grass. The influence of weeds in this matter of unfavorable effect of one plant on the other is also considerable, apart from their undesirability in lawns because of their appearance.

As far as lawns are concerned this influence is perhaps most noticed in the relationship of trees and grass, a relationship which is only too often the cause of poor lawns under or in the neighborhood of trees. Bare places under trees are of very frequent occurrence and are usually, and often erroneously, attributed to shade. There can be no question that shade plays an important part in many cases, but usually it is only a contributory factor and the bare places often on closer observation are found to be most developed on the side least subject to shade, and on the lower side so far as drainage is concerned. The retention of washings from the leaves and bark of trees is undoubtedly a factor in the infertility of soils in the vicinity of such trees. This influence of one plant on another of the same kind growing in succession in the same soil, or of the influence of one plant on another of an entirely different kind, and the influence of the soil texture, nature of subsoil, and other chemical, physical, and biological factors upon such plant influences or associations will serve to make clear the many antagonisms between grass and weeds, and grass and trees,

shrubs, and other plants so often encountered in lawn building and landscape gardening. Such influences are apt to be observed more generally in soils not well adapted for the purposes for which they are used, owing to faulty texture, bad drainage, poor subsoil conditions, and other defects, so that the nature of the soil becomes really the determining factor.

## SOIL BUILDING FOR LAWNS, PARKS, PARKED EMBANKMENTS, AND TERRACES.

Some of the principles of soil building applicable to such cases as involve the alteration of soil already in place, the addition of surface soil over soil already in place, and the filling in and leveling of unsightly and unsuited places, for the establishment of private grounds, city parks, and terraces of many kinds are noted in the following pages. These principles govern all cases where soil is to be transported from one place to another, the object being to establish a greensward on the soil in its new environment. Specific advice or directions applicable to all large civic improvements can not be given on account of the necessarily local nature of the problem. General principles can, therefore, only be emphasized.

### PROPER AND IMPROPER FILLING-IN OF SUBSOIL MATERIAL.

The utmost care in supervision should be exercised in regard to the material used in the building of the soils of larger city parks where filling-in is often a necessary step. Had such simple precautions been followed in the past, poor public parks and lawns in public grounds surrounding public buildings of all kinds would not now be encountered. The remarks here made apply only to the last 4 feet or so of filling and not to cases where very deep fillings are made. Building débris, bricks, and other coarse material should be absolutely barred from these last 4 feet.

For the reasons already discussed the soil material which is to serve as subsoil should be preferably of heavier texture than the surface soil available for the lawn, and never of a distinctly sandy nature, if goods results are desired. The heaviest material of the subsoil should be filled in first and as near as practicable distributed evenly over the entire area to be filled in. In large parks each lawn should be considered as a unit. It would seem needless to remark that old sidewalks, cement cellars of former buildings, etc., should first be removed, or at least thoroughly broken up, and yet experience has shown that this precaution is seldom complied with. The lighter material of the subsoil should then be hauled in on top of the first layer and spread out in an even layer. Where the material for the fill is all of the same kind and texture, this precaution is unnecessary, but wherever layers are likely to be formed each should be uniformly

distributed over the entire area. The heavier layer should be the lowest and all the layers should blend one into the other. Distinctive layering and patches of different cross section in different parts of the lawn should be rigorously avoided. In other words, the usual practice of dumping a load of clayey soil here and a load of sandy soil there, or of dumping a load of clay on top of a distinct sand, can not but fail to bring about a lack of uniformity in the subsoil of the lawn, resulting in different soil conditions establishing themselves in the course of time, giving patched lawns with poor and good sections or different grasses growing over the different soil conditions in the subsoil, even if the surface soil be uniform. The importance of the subsoil in the building of lawns can not be overestimated and the greatest care should be exercised where this is

FIG. 5.—Faulty soil building on public grounds. The result of not specifying the nature of the subsoil to be hauled in by the contractors. While the illustration can not show the promiscuousness of the soil as to texture and kind, it does show the bricks and building débris which form no inconsiderable portion of the lawn.

built up by filling in. This proper procedure of filling in for lawns costs little if any more than the haphazard way of dumping the material anywhere without due attention to texture and evenness of layering. In making the subsoil, the source of the material is, of course, not so vital a matter as with the surface soil, but the more nearly it is like a good surface soil the more desirable.

### HAULING IN OF PRODUCTIVE SURFACE SOIL.

The surface soil of a lawn must have been a good surface soil in its previous situation. It should be especially selected with due regard to the texture of the soil already in place as subsoil and especially in regard to its natural productiveness. The surface soil should blend with the subsoil; that is, its texture should not be markedly different from the subsoil and it should be lighter and loamier than the subsoil

for the best results, unless the subsoil provided is sandy and loose. It is preferably obtained from a cultivated field, as this insures the best soil condition with the least danger of importing weed seeds. Inasmuch as the soil is to be put into permanent sod it is, moreover, better to have had other crops immediately preceding its establishment. It should never be taken from clay or sand banks, cuts or excavations, or similar situations, as no amount of doctoring with fertilizers, manures, or lime will make such soil immediately productive and suitable for a lawn without previous cultivation and the growing of cultivated crops. Only the very best soil obtainable should be used for such purposes, and it should be further improved as far as possible by the addition of organic manures, such as stable manure and bone phosphates and in some cases by moderate liming.

The surface soil should be spread over the graded subsoil uniformly. The depth of surface soil to be hauled upon the subsoil depends somewhat upon the nature and texture of the subsoil itself. If the latter is heavy and distinctly of a subsoil character, being hauled in from clay banks or moderately deep excavations, the surface loam should be made quite deep, at least 12 inches, but may in cases where the subsoil is itself good in texture and loamy in character be made much shallower, but not less than 6 inches. The object should always be to offer a loamy substratum for the roots to an appreciable depth so that they can penetrate deeply for their water supply.

### SELECTION OF SOIL BEST SUITED FOR GRASS GROWING.

Lawns are not developed with equal success on all soils. This is due to the natural differences in soils as a result of their different formation, different texture, relation to subsoil, and to climatic conditions under which they occur and which also affect directly the grasses themselves. Some grasses are suitable for lawns under climatic and soil conditions under which other grasses perish, or at best do not reach that development necessary for the formation of a good turf. Attention has already been called to the influence of the texture of the soil on lawn building and the above statement emphasizes that thorough consideration be given to the soil region or province in which a lawn is to be established, or the soil series from which the lawn soil is to be obtained, especially where the soil is to be hauled from the country to the city for the establishing of good lawns, parks, or other public grounds.

The chief factors in this difference in soils has been brought about by the formations of soils from different geologic materials acted upon by different natural agencies, such as climate, humid, arid, semiarid; glaciers; wind; water—lake, ocean, and river. Due to such great differences in the soil-forming agencies upward of 700 individual soil

types have been found by soil surveys in the United States. These fall naturally into larger groups known as soil series, and these, again, into still larger divisions known as soil provinces.

The question of what soil is best suited for the purpose of hauling in as a lawn soil is a very broad one and is naturally a local problem. In the following list are given the soil types, which, in the States mentioned, are prominent grass soils, and may, therefore, be suggestive of the kind of soil to be used in those localities where they occur. For a detailed description of these soil types, together with maps showing their location, the reader is referred to bulletins from the Bureau of Soils,[1] and the respective reports of the areas in the individual States as far as they have been surveyed.

### Clays.

Hagerstown clay—Ala., Ky., Pa., Tenn., Va., W. Va.
Cecil clay—Ala., Ga., Md., N. C., Pa., S. C., Va.
Porters clay—N. C., Pa., S. C., Va., W. Va.
Houston clay—Ala., Kans., Miss., Tex.
Upshur clay—N. Y., Ohio, W. Va.
Vergennes clay—N. Y., Vt.
Vergennes black clay—N. Y., Vt.
Dunkirk clay—N. Y., Ohio.
Decatur clay—Tenn.

### Clay loams.

Decatur clay loam—Ala., Tenn., Va.
Dunkirk clay loam—Mich., N. Y., Ohio.
Cecil clay loam—Ala., Ga., N. C.
Hudson clay loam—N. Y.
Wickham clay loam—Va.
Cumberland clay loam—Va.
Brooke clay loam—W. Va.

### Silt loams.

Marshall silt loam — Ill., Ind., Iowa, Kans., Mo., Nebr., Wis.
Dekalb silt loam—Ala., Ind., Ky., Ohio, Pa., Tenn., Va., W. Va.
Memphis silt loam—Ill., Ky., La., Miss., Mo., Tenn.
Sassafras silt loam—Del., Md., N. J., Pa.
Norfolk silt loam—Ala., N. C., S. C., Va.
Lintonia silt loam—Ill., Ind., Ky., Miss.
Hagerstown silt loam—Pa., Tenn., Va.
Knox silt loam—Ill., Ind., Wis., Iowa, Ky., Mo., Nebr.
Volusia silt loam—Ind., N. Y., Ohio.
Wheeling silt loam—Ohio, W. Va.
Lansdale silt loam—Pa., Va.
Houston silt loam—Ala., Va.
Tyler silt loam—W. Va.
Penn silt loam—Pa.
Dutchess silt loam—N. Y.
Birdsboro silt loam—Pa.
Upshur silt loam—Va.
Oktibbeha silt loam—Miss.

### Loams.

Hagerstown loam—Ala., Ky., Pa., Tenn., Va.
Chester loam—Md., Pa., Va., W. Va.
Dekalb loam—Ala., Ky., Pa., W. Va.
Penn loam—Md., N. J., Pa., Va.
Greenville loam—Ala., Fla., Ga., Miss.
Upshur loam—Ala., Pa.
Cumberland loam—Ky., Tenn., Va.
Sassafras loam—Md., N. Y.
Decatur loam—Ala., Tenn.
Vergennes loam—N. Y., Vt.
Holston loam—Ala., Tenn.
Volusia loam—N. Y., Ohio.
Talledega loam—N. C., Va.
Dover loam—N. Y.
Wickham loam—Va.
Fishkill loam—N. Y.

### Fine sandy loams.

Norfolk fine sandy loam—Ala., Fla., Ga., La., Miss., N. C., S. C., Tex., Va.

[1] Use of Soils East of the Great Plains Region, by Milton Whitney, Bul. 78, Bureau of Soils, U. S. Department of Agriculture; Soil Surveys of the Bureau of Soils, U. S. Department of Agriculture, a list of which may be had on application to the department.

Orangeburg fine sandy loam—Ark., Ala., Fla., Ga., Miss., N. C., Okla., S. C., Tex.
Susquehanna fine sandy loam—Ala., Ga., La., Miss., Tex.
Dunkirk fine sandy loam—Ind., N. Y., Ohio, Wis.
Sassafras fine sandy loam—Md., N. J.
Wheeling fine sandy loam—Ohio, W. Va.
Cumberland fine sandy loam—Ala., Ky.
Greenville fine sandy loam—Ala., La.
Dover fine sandy loam—N. Y.

**Sandy loams.**

Hagerstown sandy loam—Ala., Pa., Tenn., Va., W. Va.
Cecil sandy loam—Ala., Ga., N. C., S. C., Va.
Carrington sandy loam — Ill., Kans., Minn., N. Dak., S. Dak.
Sassafras sandy loam—Del., Md., Va.
Collington sandy loam—Md., N. J.
Greenville sandy loam—Ala., Fla.
Superior sandy loam—Wis.
Tifton sandy loam—Ga.

## THE IDEAL SOIL.

The ideal soil for grasses best suited for lawn making is one which is moderately moist and contains a considerable percentage of clay—a soil which is somewhat retentive of moisture, but never becomes excessively wet, and is inclined to be heavy and compact rather than light, loose, and sandy. A strong clay loam or a sandy loam underlaid by a clay subsoil is undoubtedly the nearest approach to an ideal soil for a lawn; it, therefore, should be the aim in establishing a lawn to approach as near as possible to one or the other of these types of soil. In many localities it will, however, be very difficult to produce by any artificial means at one's command a soil which will approach in texture either of the types recommended. Our efforts should, nevertheless, be directed to attaining as closely as possible these ideals.

## GRADING SOILS FOR LAWNS.

Where a pure sand or a light sandy soil is the only foundation for the lawn, a top dressing of 2 or 3 inches of clay should be given and incorporated with the first 4 to 6 inches of the sand, and after this, if possible, the area should be used for the production of some green crop which gives an abundance of vegetable matter.[1] In latitudes south of Washington, D. C., cowpeas and soy beans, and in districts north of this red clover, vetches, and Canada peas are suitable for this type of soil improvement. These crops, if allowed to occupy the land until their maximum growth is attained and then plowed under, will act very beneficially upon the structure of the soil in making it more retentive of moisture, better able to hold fertilizers applied to it, and less liable to allow the greensward upon it to be killed out in times of drought.

Before definite preparations are made for the seed bed, the surface of the lawn should be reduced to the desired grade. In large areas

[1] In addition to the green manure, a liberal dressing of well-rotted stable manure will add available plant food as well as increase the store of humus. A dressing of 20 two-horse wagonloads of such manure to the acre is not too much for quick returns and lasting effects.

a gently undulating or broken surface is much more pleasing than a uniformly graded surface. Such a surface also adapts itself better to plantations of trees and shrubs. For small grounds of less than an acre in extent the grading should be comparatively uniform and of the simplest possible character. The general statement made in regard to the contour of the surface is sufficient for guidance in grading such small areas.

In the establishing of lawns all grading should be done while the land is in the rough, just after the first breaking of the soil by plowing. When the surface soil is deep and the grading slight no special care is required, but where the soil is shallow or the regrading to be done considerable, care must be exercised so as not to make the surface soil so shallow as to prevent the proper growth of grass. Where the regrading is considerable, the proper procedure is to take up the surface soil and put it aside; then do all the necessary grading on the subsoil thus exposed. When the subsoil is thus brought to a grade, it should then be examined. Wherever an excavation has been made of sufficient depth to expose a subsoil different in appearance from that immediately below the top soil removed, its character should be determined. If hard and impervious to root growth it should be thoroughly plowed or otherwise loosened before replacing the top soil. An application of coarse manure would be helpful. If this plowing is not done, an allowance of at least 3 inches additional top soil should be made on these portions. After grading, the surface soil is uniformly spread over the land. This is a more economical procedure than to haul in fresh surface soil in after years to renovate the impoverished sections of the lawn where the subsoil was exposed and, furthermore, avoids the difficulty often found in procuring surface soil. In figure 6 is shown the right and wrong way of soil grading.

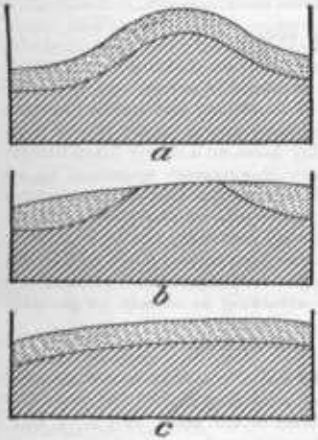


FIG. 6.—Proper and improper soil grading. a, Soil to be graded; b, improper grading, showing exposure of subsoil; c, proper grading.

### PREVENTING EROSION ON TERRACE BANKS.

As in grading, the exposure of subsoil must be avoided in making terraces on lawns. Erosion during heavy rainfall is an especial menace to terrace banks. For this reason a soil least subject to soil erosion should be used in their construction, especially in those cases where the terraces are artificially formed by the hauling in of soil. The surface soil should be one having a good structure and tilth, as a soil well granulated by thorough previous tillage, cultivation, and liming is less liable to erosion. The surface soil should blend well with the subsoil, and the latter should be one which will admit

FIG. 7.—An eroded terrace bank. In terracing, proper attention must be paid to preventing erosion. Erosion during heavy rainfall is an especial menace to terraces. A soil least subject to erosion should be used in its construction and the surface soil should have a good structure or tilth, well granulated by thorough tillage and liming.

of rapid drainage, with no tendency to form hard or dry layers, impeding the downward movement of water. In stiff subsoils these drainage factors can be greatly helped by tile drainage, as on level land, thus insuring the percolation of water through soil and subsoil rather than over the surface of the terrace slope.

### TILE DRAINS IN LAWN SOILS.

Proper drainage is a matter which is usually overlooked in laying out lawns, even where these are in large parks or estates. Land that is not naturally able to absorb any ordinary rain, forming pools or water-logged sections, or land which is naturally cold, is not well

suited for lawn grasses until it has been underdrained. Underdrainage is so generally recognized as a prominent factor in improving unproductive lands for general agricultural purposes that it is surprising that it has not receivd more attention in the making of lawns and parks. Drainage has the effect of improving the fertility or productiveness of the lawn soil by carrying off excess of moisture, making it more open in structure, with improved aeration and bacterial activity, and making it warmer, an effect which is especially noticeable in the spring by the early awakening of the grass, and moreover tends to establish a much denser turf early in the growing season.

Tiles should be laid 3 to 5 feet deep and from 5 to 20 feet apart, depending upon the nature of the soil. No definite directions can be given in this regard. Much skill is required to dig the trenches accurately and to lay the tile properly. All tile should be laid several months before sowing the grass seed, so as to allow the ground to settle completely. The main tiles should be larger than the lateral tiles and a uniform grade be established toward the outlet. This outlet could be easily made in most parks by connecting the drainage system with the sewer pipes, and the same can be easily accomplished in the smallest lawn.

The effect of tree washings and tree roots on grass, and also of grass on trees, has been mentioned. Here, again, the use of tile offers the logical remedy. Tile should be laid on each side of the tree, preferably at the time when it is planted. This will serve to carry off the charged water running from the tree, and cause a better aeration and consequently destruction of débris from the tree. It will make the soil deeper and more productive for both the tree and grass, and by causing the tree roots to penetrate deeper into the soil prevent the interference of the roots of grass and tree with each other. In time the tree roots may get into the tile drains and prevent the free flow of ground waters. The object of laying the tile will have been largely attained before this happens. The tree roots may, however, be removed, as is done in tile-drained orchards, by means of a stiff wire brush on a cable. A further suggestion for removing the washings from trunks of trees, where this is found to be detrimental to grass, is to have a depression about the trunk or a slight embankment of sod, or even a collar of cement, around the base a foot or two from the trunk, and connecting the basin thus formed with the underdrainage system by means of an upright tile. The soil and subsoil should be kept separate in digging the trenches for the laying of tile, so that the surface soil can be again put on the top when the trench is filled.

## PREPARATION OF THE SOIL.

Since the lawn is intended to be a permanent feature of the decoration of a place, its endurance or span of life is of utmost importance. In general, grass seeds are small and the surface seed bed for the reception of these seeds need not be more than 1 inch in depth; but since the grasses, as they become established, send out long lateral feeding roots, it is necessary that the soil area available for these plants should be as great as possible. This object can only be obtained by deep cultivation and thorough preparation of at least 8 or 10 inches of the surface soil. The soil to this depth should be made rich and put into an ideal condition for the development of plant roots. The mechanical operations of preparing the soil can be carried on by the use of the modern plow if the area is large enough, or by spading if the area is small. All weeds, roots, and other débris should be removed both before plowing is begun and as they appear in the process of the work. The seed bed should be thoroughly

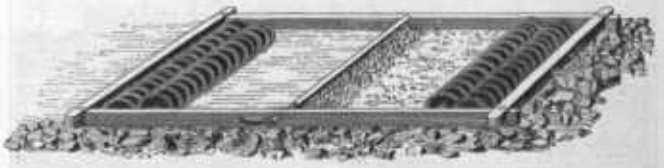

FIG. 8.—Harrow for smoothing and fining the soil preparatory to sowing the seed.

and frequently stirred. In short, the land is treated just as good farm or garden land should be treated for raising an especially valuable crop. If the soil is very rough after plowing, a disk harrow should first be used to cut up the clods. Where hardpan exists, or where the subsoil is otherwise hard, stiff, or refractory, the subsoil plow should be used. Subsoiling, which consists of stirring up the subsoil without bringing it to the surface, is often of great advantage where the surface soil is thin.

Cultivation should also have for its object the destruction of weeds which may interfere with the establishment of the lawn or which may be detrimental to it after it is once established. After the soil has been throughly plowed or spaded it should be carefully fined by harrowing or raking, after which it should be thoroughly compacted by the use of a lawn or field roller and the surface again loosened by the use of a steel-toothed rake or a specially constructed harrow, such as is shown in the accompanying illustration (fig. 8). This implement is frequently used by gardeners for the purpose of accom-

plishing on a large scale the results obtained by the use of a steel hand rake on small areas. This treatment will produce a suitable seed bed for the reception of the fine seeds of the grasses.

After the seed bed has been thoroughly and carefully prepared and the grass seed scattered in appropriate quantities, according to the kind used, the surface should be given a careful raking or rolling if the area is dry. If showers have been frequent, raking after the seed has been sown will suffice until after the grass has reached a height sufficient to be clipped by a lawn mower. Prior to clipping the grass with a lawn mower, if the ground was not rolled after

FIG. 9.—The cowpea used as a soil-improver in making lawns.

seeding, a heavy lawn roller should be passed over the surface in order to make it as smooth as possible. After the grass has an opportunity to become erect it should then be clipped with the mower.

## FERTILIZERS.

Since the lawn is a permanent feature, it is hardly possible to make the soil for the reception of the lawn too rich. Stable manure which has been thoroughly composted and rotted and which is as free as possible from detrimental weed seeds is undoubtedly the best material to use in producing the desired fertility of the soil. Forty to sixty loads of well-decomposed stable manure are not too much to use upon an acre of land designed for the greensward. Where such stable manure is not available the next best plan to follow is that previously suggested—the plowing under of green crops, such as clovers, cowpeas, soy beans, and similar plants. The land should

then receive an application of about 1,000 pounds of lime to the acre, and at the time of preparing the seed bed 500 to 1,000 pounds of fine-ground bone, together with 300 to 500 pounds of a high-grade fertilizer upon each acre. The fertilizer may contain 3 per cent nitrogen, 6 to 8 per cent phosphoric acid, and about 8 per cent potash.

The fertilizer improvement above suggested is to be made on what is already a fair soil and one which has been a surface soil for some years. If the soil is texturally good, but is in bad physical condition otherwise, or is a raw soil—that is, one which has been a subsoil in its former position—then it is necessary first to change this into a surface soil with good tilth and structure by treating it with manure, fertilizers, and lime and growing cultivated crops on it for a year or two. A soil which will not grow a good crop of corn or potatoes will not grow a good crop of lawn grass. The cultivation of the ground during the growth of the crop will gradually make a soil out of the raw subsoil, and this should be continued until it is sufficiently good to grow a good potato or corn crop. Crops to be plowed under as green manure, such as cowpeas or rye, are desirable. These precautions will insure a good soil for the growth of a permanent greensward and will pay for all the labor expended, especially as without these precautions only an indifferent lawn can be obtained on such soils. When the soil is ready for the lawn give it its final treatment with lime and fertilizers and seed to grass.

## GRASSES ADAPTED TO LAWN MAKING.

It is evident that not all grasses are adapted to lawn making. Only such kinds as are capable of making a close turf are ideal for lawns. Most grasses which have creeping root stocks, short joints, and produce long, narrow leaves in abundance about the crown of the plant adapt themselves well to lawn making. Besides this, a desirable lawn grass possesses a pleasing color, which does not change decidedly from season to season, is drought resistant, responds quickly to a change of conditions from winter to spring, and bears repeated clippings with a lawn mower. It will be noted that the requirements of these grasses are exceedingly exacting, and it is not surprising to find the list of such grasses a comparatively short and meager one.

In those localities where ideal soil and climatic conditions are not present a mixture of grasses is better adapted to lawn making than a single variety. Under conditions where the soil and climate are congenial for the development of grasses a more perfect lawn can be made by using a single species than by the use of a mixture. In general,

because of varied conditions of shade and moisture existing upon a lawn as the result of trees, shrubs, and architectural objects, mixtures are more desirable than pure grasses. The different degrees of shade and moisture maintained in the soil which result from the presence of trees, shrubs, and buildings afford a variety of conditions under which a single species would not produce a uniform lawn. These obstructions to the sunlight produce lights and shades in different parts of the lawn, so that any difference which may exist in the color of the various grasses in a lawn mixture is not so obtrusive as it would be were different portions of the area made up of grasses of different hues. Even if there is variation in the tints of the green in the different grasses used in a lawn mixture, this will not become objectionable

FIG. 10.—A good blue-grass lawn on soil properly filled in and prepared.

unless the lawn becomes patched and made up of one variety in one place and a different variety in another.

### FOR SUNNY AREAS.

Kentucky bluegrass is undoubtedly the great American lawn grass. It thrives best in a comparatively retentive, strong soil, where there is an abundance but not an excessive amount of moisture. It is adapted to all the Atlantic coast region north of Washington; to the clay lands and lands with clay subsoil in and near the Allegheny region south to Georgia and Alabama; to the Mississippi Valley south as far as Mississippi and including the Ozark Mountains in Arkansas and west to the Missouri River; to the irrigated sections of the Rocky Mountains; to both the humid and irrigated lands of the Pacific coast

south to Los Angeles. Its chief companion is redtop through practically all these regions, especially on the lighter soils. These two grasses make up from one-half to two-thirds of most of the leading grass-seed mixtures sold in the regions mentioned. Most of the largest makers of lawns use 2 parts by weight of Kentucky bluegrass to 1 of redtop. The soil that does not suit one of these grasses is likely to be suitable for the other, so that a good lawn will result, except perhaps on the lightest lands. The nurse crop for this combination is white clover. Rhode Island bent and creeping bent have the same ability to make a compact, thick sward as does Kentucky bluegrass and with the redtop thrive on lands too light for

FIG. 11.—A typical bluegrass and white-clover lawn. The recent use of the mower has left a striped effect upon the greensward.

success with the Kentucky bluegrass. Under certain conditions redtop and the bent grasses are able to make a softer, although not a more permanent, turf than does the bluegrass.

Other good grasses as part of a general mixture or for special conditions are Canada bluegrass, the fescue grasses, wood meadow grass, and sweet vernal grass. White clover makes a beautiful lawn quickly, but is soon crowded out in the presence of a good stand of the best lawn grasses under the close cutting which a well-kept lawn requires. It answers a good purpose in protecting the young grasses the first year. This is especially necessary with bluegrass, which is weak and tender until the second year.

Seashore lawns are each year becoming of more and more interest because of the great number of residences which are being established along the Atlantic coast from Maine southward. While there are known to botanists a number of forms of common grasses besides bluegrass and redtop which are maritime, none of these have been taken up by commercial seedsmen and produced in sufficient quantities to be available for lawn making in these regions. Persons wishing to establish lawns under these circumstances must therefore depend largely upon the same grasses that are used for the making of lawns farther from the coast—Canada bluegrass, Rhode Island bent grass, redtop, white clover, the fescue grasses, and especially creeping

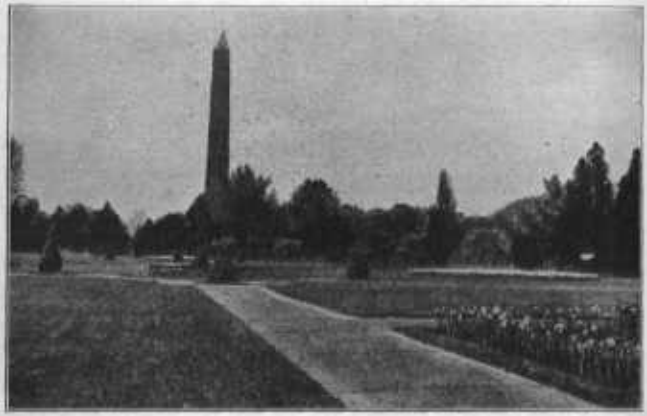

FIG. 12.—An excellent mixed-grass lawn on the Agricultural Department grounds, Washington, D. C.

bent. Under coast conditions it is advisable to use even more liberal mixtures of these grasses than in sections where lawn making is thoroughly understood and where a single species may be used with certainty in establishing a satisfactory lawn. If the seed can be obtained, the seacoast bent grass is a valuable addition to the above list.

From the city of Washington southward, particularly upon the sandy soils of the Atlantic coastal plain and along the Gulf, Bermuda grass is the main dependence for lawn making. Near the borders of the bluegrass region this may be in combination with bluegrass or with bluegrass and white clover. The Bermuda grass will grow in the hot sunny weather of summer, which burns the bluegrass. The

frosts will brown Bermuda grass, but bluegrass keeps the lawn green through the winter. Where the bluegrass will not thrive, Italian rye grass is sown each fall in the Bermuda grass. It gives a green turf during the winter and dies in the spring. It is suggested that white clover be tried in this same way from Norfolk southward. To accomplish this, about October 1 clean off the Bermuda grass as thoroughly as possible with a scuffle hoe, then loosen the top 2 inches thoroughly for a fine seed bed, but do not remove the roots of the Bermuda grass. On this seed bed sow either white clover at the rate of 25 or 30 pounds per acre or Italian rye grass at the rate of 2 bushels per acre and roll lightly. This should give a satisfactory green cover during the season the Bermuda grass is unsatisfactory. As hot weather approaches the Bermuda grass will crowd out the other grass. This seeding will have to be repeated annually in order to have the lawn green during winter. Where it will thrive, the bluegrass-Bermuda turf will probably be more satisfactory.

This mixture of the two grasses must be practically uniform throughout. Lawns in which Bermuda grass has gained an entrance and killed out bluegrass in places present a very unsightly appearance after severe frosts have occurred in the autumn, the bluegrass remaining bright and green while the Bermuda grass, after having been frosted, turns light brown, thus presenting a very spotted and unattractive appearance (see fig. 12). Under these conditions the Bermuda grass, which in general may be considered a good and desirable lawn grass, becomes a weed. Another weedy grass which is likely to produce a similar effect upon lawns in which the grasses have "run-out" is crab grass, as shown in figure 19.

When the confines of Florida have been reached, however, the conditions are somewhat different and the warmer climate and the greater humidity allow different species to endure, as, for instance, the St. Augustine grass, which has a coarse and very upright leaf, although it has a creeping rootstock. This grass is of special value in Florida, as it remains in a green condition practically throughout the whole year.

Korean lawn grass is a maritime grass from Asia and Australia, which is proving of value along the seacoast from Charleston southward. It thrives well in the latitude of Washington, but the leaves are not hardy and assume a light straw color in winter. It will, however, undoubtedly be a decided acquisition for lawns near the seashore in latitudes south of Washington. In Texas the mesquite, a native grass, is ranked with Bermuda grass as a desirable lawn grass.

For certain areas west of the Mississippi River, where the grasses already mentioned do not thrive, it has been suggested that a native grass known as buffalo grass, which has the characteristics of a good lawn grass, that is, creeping stems and short, upright leaf shoots, be

employed for lawn purposes. This grass has ability to withstand drought, and to establish and maintain itself under adverse climatic conditions. Since buffalo grass is indigenous to the region and possesses so many qualities which are of importance in a lawn grass it is worthy of special consideration in this area. It has the one drawback that the seed is not now available in commercial quantities. On the sandy lands of the Pacific coast from San Francisco south the rye grasses and Bermuda grass are apt to prove the most satisfactory.

There are a few grasses which in themselves are well suited to lawn making, but which because of their habits of growth are not well adapted to use in lawn mixtures. Italian rye grass is a notable

FIG. 13.—A patch of Bermuda grass in a bluegrass lawn in winter.

example of this type of plant. It is in itself capable of making a fairly good lawn, but because of its more rampant growth and broad leaf blades, which possess a shiny appearance, it does not blend well with other grasses on the lawn—such as redtop, bluegrass, and white clover. It grows more rapidly than do these species, and always appears as an obstrusive companion on the lawn. It is, therefore, not advised as an important or desirable feature in a lawn mixture.

Perennial rye grass is sometimes recommended for lawns, but in lesser degree has the same objection as the Italian rye grass. It is often used in mixtures for quick results. It usually dies out in two or three years, but always gives a lawn a weedy appearance.

## FOR SHADY PLACES.

Lawn grasses do not thrive equally well in sun and shade. In dense shade it is usually impossible to maintain a turf. This difficulty is especially pronounced in small city yards and in the grass strips under unthinned Norway maple trees on a city street. There are three factors that may contribute to this trouble: (1) Shade; (2) local drought caused by the twofold action of the tree in keeping rain from the ground under it by the denseness of its foliage, and by the absorption of moisture and plant food by its roots; (3) a possible poisonous action of the tree on the soil as already mentioned. Probably the second factor is the most important as dense foliaged shallow rooted trees are the most difficult under which to keep grass. However, in a drought when large open areas of lawns are brown and parched, it is often noticeable that the grass under the limbs of the surrounding trees has the richest color and keeps growing slowly. The Rhode Island bent, creeping bent, and Canadian bluegrass do well in shade. The latter is a grass that is persistent in gravelly lands and under considerable traffic. It does not make as fine a turf as the other shade grasses, it being rather wiry. The red fescue and the sheep fescue are also desirable shade grasses. Unless the sheep fescue is crowded, it is apt to grow in clumps or hummocks. For this reason it is best used in mixtures and where the seeding is heavy. Orchard grass is a coarse grass that also grows in hummocks, but where crowded with some other grass it will often enable one to get a turf where otherwise it is impossible. It should only be used when the better grasses are known not to succeed. In attempting to seed in shade it is advisable to use as many promising varieties as possible in the hope of finding those that will respond to the particular conditions. On broad areas in sun it is desirable to use just as few varieties as possible. For the small home lot it would be better to use a mixture for these conditions of both sun and shade have to be met.

By a proper selection of the kinds of grasses sod may often be maintained where the conditions are quite severe. Kentucky bluegrass stands shade well, especially where not subjected to severe tramping, and is the basis of shade mixtures as offered by seedsmen. In the South it does better in the shade than in the open. The wood meadow grass is the very best of shade grasses for the regions where Kentucky bluegrass and redtop flourish. Formerly this grass was added in large quantities to the ordinary grass mixture to make it a "shady nook" mixture. Its excessively high price in recent years has largely prohibited its use except in a small way.

Along the Gulf coast the grass known as carpet grass is well adapted to shade and is a strong competitor of Bermuda grass for

all lawn purposes. It has a habit of growth very similar to that of Bermuda grass, and it is possible that when it shall have been given a thorough test its region of adaptability will be coextensive with that of Bermuda grass. Under some conditions it thrives and maintains itself to even a greater extent than does the Bermuda grass. It also has another advantage in that in certain localities it produces seed which with little care may be gathered and may become a commercial commodity. Whether or not carpet grass will carry its seeding habits to its northern limits remains to be determined. It is readily propagated from turf, like Bermuda grass, and can be easily established upon a lawn, but it is not so difficult to eradicate if that should be necessary.

Another good grass for shade on clay lands in the moist regions of the extreme South is the large water grass, while the knot grass is good on sand under the same conditions.

So many of the fescue and bent grasses being indigenous to or naturalized in the Rocky Mountains and the neighboring plains, it seems that the lawn grasses of the future for these regions must be found among these plants.

On the Pacific coast south of San Francisco the rye grasses are the most promising for use on sand in shade.

### FOR TERRACES AND TERRACE BANKS.

Terrace banks are an abomination that should be avoided if possible. They have their place in landscape design, but their use has been abused. The influence of a style of gardening in vogue nearly two generations ago, and the practice of railroad engineers who treat their station grounds with the same ideals as their right of way, still have their effect upon the ordinary contractors and gardeners who are responsible for most of the work on small places. Many a city lot has been spoiled by grading it as in *a* and *b* of figure 14, when it could more cheaply have been given the pretty contours of *c* in the same figure.

If the style of the place has demanded a terrace it is fair to assume there are ample funds to provide ideal conditions for the maintenance of the lawn on this area; soil of ideal texture and fertility, and proper means of irrigation, so the only thing left is to select the one or two kinds of grasses adapted to the climate, Kentucky bluegrass for nine-tenths of the United States, carpet grass, St. Augustine grass, or possibly Bermuda grass with Kentucky bluegrass in the remaining tenth. There are legitimate terrace banks and other legitimate banks in landscape work that must be treated besides the illegitimate ones mentioned. Wherever possible these should be covered with creeping shrubs, woody vines, or trailing plants. Grass should

be used only where harmony absolutely demands it. The objections to a grass bank are two: First, the difficulty of maintaining a close turf on a steep incline; second, the great difficulty and consequently additional cost in keeping it properly trimmed. Where grass is chosen for the covering sodding is usually the most satisfactory. For the bluegrass regions the Kentucky bluegrass is best on clay soils. On lighter soils use Canadian bluegrass; Rhode Island and creeping bent; sheep, red, and hard fescues. As a last resort in difficult places use orchard grass with plenty of other grasses. In any case, keep reseeding constantly and heavily. From Washington, D. C., to Texas, outside of the bluegrass region, use Bermuda grass. In California from San Francisco southward use Pacific rye grass, or Bermuda grass on the lighter soils.

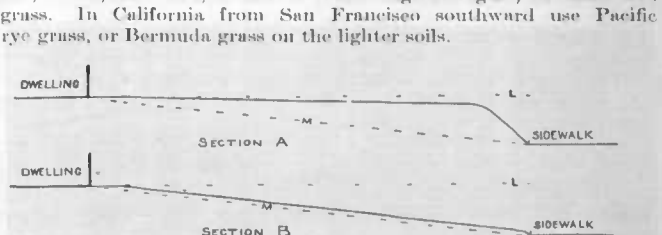


FIG. 14.—Cross sections of bad and good grading of small front yards. *L* indicates the level of the house foundation, and *M* a straight line from the top of the house foundation to the sidewalk level. *Section A:* Bad, with the rare exception of where a strictly formal treatment is admissible. *Section B:* Bad. *Section C:* Good. This ogee curve may be short or long to accommodate the difference in height between the dwelling and sidewalk, and the distance between them.

## OTHER GROUND COVERS.

On banks too steep for walking over readily upright shrubs may often be planted appropriately. If the banks are liable to wash, such drooping shrubs as drooping golden bell or matrimony vine can be used to advantage, their drooping stems running along the ground and rooting at frequent intervals and holding enough leaves to prevent wash. Such bushes will often form a mass of foliage 6 feet high. Where lower forms are essential, Japanese honeysuckle, Virginia creeper, or English ivy may be used, or the more herbaceous plants like moneywort, creeping Jenny, and myrtle. These plants are as easy to establish on a bank as turf. They do not require weekly clipping. After once established they only require a little time occasionally to remove a bit of grass or a weed

or the training of a stray branch. They make a more perfect cover than grass, and maintain themselves better. The Japanese honeysuckle may become a nuisance by climbing over any bushes, fences, or walks within reach. Its seed is easily carried by birds, it is already naturalized over a large part of the Eastern States. The Virginia creeper is not quite so persistent but is native over the whole country. The English ivy is not hardy in the northern sections. In the extreme South the variety Hibernica should be used. For ground cover in shade where it is difficult to grow grass, the English ivy, moneywort, myrtle, and a Japanese form of the mountain spurge are excellent.

FIG. 15.—Steep bank facing north; partially shaded by trees; creeping jenny at the foot of the slope, moneywort on the face of it, and flowers at the top. A neat lawn can not be maintained on a bank like this, and an ordinary one only with great care.

## SEED.

In procuring seed for establishing a lawn, too great care can not be exercised. Pure seed, of high germination, is of great importance in securing a good stand of grass. Pure seed is the keynote to a clean lawn, provided the work of preparing the land has been efficiently done. Thorough preparation involves not merely the mechanical treatment of the soil to reduce it to a proper seed bed, but the use of weed-free manure and the adoption of a course of treatment previous to preparing for the lawn which shall serve to eradicate weeds. Such preparation, coupled with pure seed, should

give a satisfactory stand of grass which shall need only the usual care necessary to maintain a lawn after it is once established. Too much can not be said in favor of securing pure seed, and, if possible, specially selected seed. This is of course of considerable importance with light seeds like bluegrass, redtop, and seeds of the bent grasses. In the case of bluegrass, select seed weighs about 22 pounds to the bushel, while the ordinary grade of bluegrass, although it may be called pure, averages about 12 pounds to the bushel.

Select or recleaned bluegrass is therefore the most economical to buy, although the original cost is considerably more than that of the common article. The stand of grass resulting from the use of re-

FIG. 16.—A grass bank better than the average on slopes, especially under city conditions.

cleaned selected seed is much more uniform than when seed containing a great number of hulls and light seeds is employed. The same remarks hold with the bent grasses and even with white clover, although the market at the present time does not offer as much opportunity for selection with this last-named seed as with the bluegrass. With redtop, however, there is an even greater opportunity of choice than with bluegrass, it ranging from pure seed, from which most of the hulls and all of the chaff have been removed, to seed containing hulls, chaff, and foreign matter. Buyers in small quantities should purchase the extra fancy recleaned seed that contains no chaff and comparatively few unhulled seeds. Buyers of large quantities should familiarize themselves with the different grades, as often it is true

economy to purchase a good sample of unhulled redtop rather than the hulled. There is no lawn grass seed so difficult to pass upon intelligently. Fancy recleaned seed should weigh 45 pounds to the bushel. Chaff redtop will weigh as low as 10 pounds. It is seldom policy to buy seed weighing less than 16 or 18 pounds to the bushel.

The quantity of seed to be used upon a lawn is of decided importance. It is better to use an excessive amount of seed and allow natural selection to eliminate the weak specimens rather than to seed sparsely with the hope that the natural habits of the plants will be sufficient to enable them to take possession of the entire area. A thick stand of plants of the desired species gives little opportunity for the development of weeds, while a thin stand of the same species

FIG. 17.—A bank of English Ivy in Washington, D. C., only four doors from the bank shown in figure 16, in front of the same row of houses.

offers a place for the growth of weeds, which may become determined competitors for the possession of the ground, thus subjecting the gardener to the necessity of eliminating the weeds or of reestablishing the lawn. Heavy seeding of grass is therefore a very important matter in the establishment of lawns.

Bluegrass, bent grass, and the fescues, if used in combination, should be sown at the rate of 3 to 5 bushels of seed to the acre. Bluegrass, if used alone, should not be used at a rate less than 50 pounds to the acre, while 70 pounds is better. White clover, if added to the collection of the above-named sorts, should be used at the rate of one peck to the acre. Upon sandy or gravelly lands and in spring seeding white clover is an important factor, because it germinates quickly

and covers the ground, affording protection and presenting an attractive appearance earlier than is possible by the use of other grasses. White clover, too, is able to reestablish itself very quickly after periods of severe drought, and until the bluegrass, redtop, bent grass, and fescues become thoroughly established the white clover will usually be in the ascendant. As the turf-forming habits of the other grasses become more marked, however, the white clover will gradually disappear and give place to the other more permanent grasses.

## ESTABLISHING A LAWN.

The successful establishment of a lawn depends upon the careful preparation and the proper fertilization of the land and the selection and planting of appropriate grasses. In those localities where a lawn can be established by the use of seeds the preparation of the seed bed and the selection and sowing of the seeds are exceedingly important questions. General directions for the preparation of the soil have already been suggested. In order that seeds of suitable character may be secured, it is desirable in the first place to determine the varieties which succeed best in the locality.

The largest users of lawn grass seed in the Mississippi Valley and northeastwardly to the Atlantic from Washington northward use Kentucky bluegrass and redtop, either equal parts, by weight, or more often two parts bluegrass and one part redtop, sowing in either case 70 pounds to the acre, and in most cases sowing also 6 quarts of white clover to the acre. In the irrigated sections of the country bluegrass alone or bluegrass and white clover seem to be the preference. The best lawn mixtures on the market are composed of approximately one-third Kentucky bluegrass, almost as much redtop, with Rhode Island bent, creeping bent, sheep fescue, red fescue, and a little sweet vernal grass to give the lawn a pleasant odor when cut. Wood meadow grass was formerly added to this in large quantities to make it a mixture for shady places, but on account of its high price the fescue grasses are now more largely used. These mixtures are admirably adapted for ordinary conditions of light and shade, dry and wet, of the average lawn.

Bermuda grass seed is not commercially grown in the United States, and because of the expense of the Australian product the only economical means of propagating this grass is by division of the rootstocks.

In those sections where seed sowing is depended upon a very finely compacted upper stratum of soil is essential. In order to secure a uniform distribution of the seed, the seeding should be done in two directions. The seed should be divided into two lots, one of the lots being scattered in one direction across the land and the other scattered at right angles to the first. This is done in order to obliterate as far as

possible balks and streaks in scattering the seed. It is best to divide the land into strips 6 feet wide, stretching strings in the case of a small lawn, or by a light, easily devised horse marker for large areas. Then a man should be given each strip to sow by bending his back and scattering the seed evenly through his fingers, held close to the ground. Grass seed can not be satisfactorily sown by the method used for broadcasting grain or clover seed.

Since grass seed is very small, every precaution should be taken to bring the seed in close contact with the soil. Nature does this in an ideal way by gentle showers. It is therefore desirable upon small areas to sow the seed immediately before a shower. If the shower is a gentle one of some duration, it is more desirable than a violent rain. Torrential rains, if the surface of the lawn is sloping, usually cause damage, which must be repaired.

After the lawn has been established and it has gone into "winter quarters" it is well to give the young grass a mulch of well-decomposed stable manure, which shall not be heavy enough to disfigure or mar the lawn, but should be so fine and well decomposed that it will be carried beneath the surface of the grass by the rains and snows of the winter, leaving very little rough or unsightly matter to be raked off in the spring. If this is not desirable, after the greensward has passed through the first winter it should be treated to a top dressing of fine-ground bone at the rate of 1,000 pounds to the acre.

In the case of establishing lawns, if the grasses which grow from seed can not be used, it is necessary to resort to one or the other of the following methods: (1) The establishment of the lawn by the use of small tufts of grass or pieces of turf planted at intervals sufficiently close to allow the natural spreading of the plant to soon take possession of the entire area or (2) covering the entire area with turf. In the Southern States, where the Bermuda and St. Augustine grasses are depended upon for lawn purposes, the common practice is to cut the turf up into small fragments about 2 inches square, or to take small tufts of roots and stalks of the grass, as much as can be easily grasped in the hand, and insert them in the soil at intervals of about 10 or 12 inches in each direction. When not planted in checkrows in this fashion the roots are usually set in rows or drills 12 or 15 inches apart in one direction with the tufts of grass 6 to 10 inches apart in the row. Slight cultivation is then practiced between these rows to keep down weeds until the rootstocks of the plant have gained possession of the entire area.

### SODDING.

Upon banks where grass can not be readily established from seed or by planting, as before indicated, the sod or turf is usually removed

from some area where suitable grass is well established and used to cover the entire surface. It carries with it all the difficulties of sod laying, greater expense, introduction of weeds and undesirable grasses, and other undesirable features. Only sod grown for such purposes is safe to use.

Where such sod is procurable, its use to quickly cover terrace banks is advisable, even though more expensive than seeding. On terrace banks the first cost of sodding is much greater than seeding, but this additional expense is perhaps no greater than that incurred by repairing a partially eroded terrace bank a second or even a third time. The laying of sod does not mean, however, that the condition of the soil on the terrace slope can be neglected because so quickly rendered invisible.

A common method employed in this work is to cut the sod into pieces a foot square and about 2 or 2½ inches thick. This answers well upon small areas if the sod is cut to a uniform thickness and the surface of the ground is made very smooth; otherwise there is more or less difficulty in getting the squares of sod adjusted evenly so as to produce a smooth surface. Considerable ramming or pounding is necessary in order to establish the desired smoothness, unless great care is exercised in cutting the turf to a uniform thickness and in providing a smooth surface to lay it upon. In order to overcome this difficulty when extensive sodding operations are to be undertaken, a device which in its action is similar to an ordinary carpenter's plane is used. Such an implement is shown in the accompanying illustration. (Fig. 18.) This device is used to cut long strips of turf. After the strips of turf have been cut by horsepower with the implement illustrated they are rolled into rolls of convenient size for handling and the sodding is accomplished by unrolling the turf over the area to be grassed. After placing the sod in position it is thoroughly rammed down with a heavy wooden maul or pressed down with a lawn roller in order to produce a uniform and smooth surface.

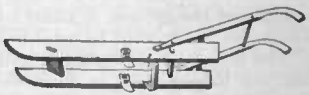

FIG. 18.—Implement used for cutting sod.

### WHEN TO PLANT A LAWN.

There is a legitimate difference of opinion in regard to the season at which it is best to plant a lawn. There are those who are very successful in lawn making who depend almost entirely upon fall planting, and there are others who are equally successful who advocate the practice of spring planting. Both of these systems are successful, and the prospective lawn maker can use the method

which best suits his convenience. If the seeding is to be done in the autumn, the latter part of August or the month of September is the best period for accomplishing the work in latitudes between Washington and Boston. In the southern portion of this zone the work may be deferred until October. The preparation of the land for this work should be thorough. The seed bed should be made very fine and every precaution taken to give ideal conditions for the germination of the seed. If possible the seeding should be done at a time when the fall rains are most abundant; but, as frequently happens, in the eastern part of the United States within the zone mentioned there is a more or less protracted drought during the fall. It is not advisable to sow the grass seed during a dry period, unless there are at hand artificial means for watering which can be used to force rapid germination and growth.

Fall planting has the advantage of allowing a number of weeds in the area to germinate and be killed by the frosts and freezes of the winter. If the grass attains a height of 2½ or 3 inches before winter there is little danger of loss from severe weather. In localities where the surface of the earth is not protected during winter by a snow cover and the ground is likely to freeze and thaw repeatedly it is not advisable to attempt to establish a lawn in the late autumn.

The drawback to spring planting is that work must frequently be delayed longer than is desirable because of unfavorable soil conditions, particularly upon heavy and retentive soils. Young plants suffer severely from heat and drought if they have not had an opportunity to grow and form considerable root before the hot period comes on. Weeds which come in advance of the spring planting of the lawn can be overcome in a measure by giving the land partial preparation in the autumn and allowing the first crop of weed seed to germinate before cultivation and the preparation of the seed bed is completed, using this cultivation to destroy the first crop of weeds as well as to prepare the seed bed for the lawn. The later weeds can be held in check by frequent clippings with the mower.

As one goes south from Washington the time of lawn making becomes later in the fall and earlier in the spring, the controlling factors being moisture with sufficient high temperature to start the seed. Where Kentucky bluegrass and Bermuda grass are to be grown together it is desirable to start the lawn rather early in the fall, so as to enable the bluegrass to get as much start of the Bermuda grass as possible. Young Bermuda grass sets would only be held in check by the cold weather of winter, while newly started Kentucky bluegrass plants would be killed by the severe, hot, dry weather if started in the spring.

## MAINTENANCE OF A LAWN.

All operations connected with the maintenance of a greensward are directed toward securing a uniform sod or turf over the entire extent of the lawn. In order to secure this the plants which constitute the lawn should be kept in a luxuriant, vegetative condition and never allowed to go to seed. There is no operation connected with plant life which is so trying upon the vitality as the production of seed. In order to keep a close, even surface over the area it is necessary to use a mower frequently, but in using the mower the clipping should not be done close enough to deprive the plants of sufficient leaf area to carry on their normal functions; that is to say, as a general rule the lawn mower should be set high rather than low. Upon newly established lawns the operation of clipping should not be delayed until the grass is too high. As soon as a mower with the blade 2 inches high will cut the leaves the mower should be passed over the surface. By repeating this at close intervals during the growing season a better and more uniform stand of grass will be secured.

It is a mistake to allow a lawn to go in an unkempt condition during the first months of its existence. It should from the beginning be subjected to the same treatment which is to be carried on later in its life. It is not advisable to clip the lawn frequently during periods of drought, but even during these periods it is not well to allow the plants to produce seed stalks. The general plan of keeping a lawn clipped to a height of 2 inches is a very safe one to follow. The clipping should be sufficiently frequent to prevent the necessity of raking off. If the soil is moist, very rich, and the growth luxuriant, it will be necessary to catch some of the clippings in a carrier on the machine for a few of the spring cuttings, but on comparatively poor soils the clippings will not be detrimental if cut frequently enough. Before growth has advanced to any considerable extent each spring, the lawn, as soon as it is comparatively dry, should be gone over with a heavy lawn roller, so as to embed firmly any of the grass roots which may have been loosened by the frosts and to reduce the surface to a uniform condition.

### WEEDS.

A weed is "a plant out of place." It thus happens that grass is sometimes the worst weed of the lawn. Desirable grasses may be scattered in patches through an otherwise well-mixed lawn and produce as bad an appearance as some other weed. Figure 13 shows a spot of Bermuda grass in a bluegrass lawn and figure 19 crab grass in a lawn. This difficulty, as most other lawn troubles, is best met by using plenty of seed frequently, plenty of fertilizer judiciously, and

the lawn mower regularly. Such treatment, while beneficial to the desirable lawn grasses, is tolerated by but few other plants. When applying the seed, rake over the bare places and the places where the undesirable plants are. Plantain, dandelion, and dock are the ones likely to give the most trouble, but even these can be kept in check by this combined treatment. Where they have a foothold it is sometimes necessary to remove them by a trowel or a knife. If it is to be done on a large scale a knife like a short-handled asparagus knife is good. If a large proportion of the lawn is covered with these plants, especially the dandelion and dock, it is better to plow up the lawn and remake it than attempt to eradicate them by hand.

FIG. 19.—Effect of crab-grass on a neglected lawn.

## FERTILIZERS.

The fertility of agricultural lands is maintained by thorough tillage, crop rotation, and fertilization. In the lawn, tillage and crop rotation are excluded after the lawn is once established, and fertilization must take the form of surface application, inasmuch as it is not then feasible to incorporate the manures and fertilizers with the soil.

It is difficult to make good soil conditions after a lawn is started when the poor conditions are due to one or all of the soil factors already discussed as causing defective lawns. Fertilization will

never make up for a lawn soil poorly prepared. No amount of fertilization will remedy such defects. If the lawn soil has been properly prepared in the first place and enriched with stable manure, lime, and bone phosphate, as described in this bulletin, it should be possible to maintain a lawn in good condition. Lawn clippings should be short and never removed except from very rich land when rains are frequent. When removed they should be caught in a carrier, not raked off. Manure is the best winter mulch, but only well-rotted stable manure should be used, otherwise it will do more harm than good through the introduction of weed seeds. Other coverings are muck and peat, compost, and tobacco stems, all of which make a good mulch. Only a thin covering is required. The benefits to the soil are that the mulch minimizes the damage from alternate freezing and thawing and that it supplies, through the leaching of winter rains and snows, dissolved inorganic and organic constituents, which sink into the soil and thus promote the good conditions necessary for grass growth.

The mulches are all unsightly, and for lawns on good soil properly prepared, from which the grass clippings are not removed, they are not essential after the first year. The manure is allowed to stay on the ground all winter and the coarse material raked off just before the spring rolling.

Ground bone is one of the best lawn applications. Phosphoric acid may also be applied in some form of phosphate rock. Potash can be supplied most economically as muriate of potash. Probably the best practice for the owner of a small place would be to apply a complete commercial fertilizer one year and then ground bone for two years. In regions where it is sufficiently cheap cottonseed meal is an excellent lawn dressing. Dried blood, tankage, fish scrap, sterilized sheep manure are all good fertilizers. All such fertilizers should be used in the fall. Spring application is better than no application, except in the case of dissolved bone or dissolved rock. These fertilizing materials have one advantage over stable manure because they contain no weed seeds. This is an extremely important consideration, so important that unrotted manure should be kept away from the lawn at all times.

Nitrate of soda at the rate of 100 pounds per acre in the spring after active growth begins is also very conducive to grass growth. It shows itself promptly in the darker green of the grass. It should be scattered just before a rain or sprinkling, or dissolved in water and sprinkled over the lawn. Nitrate of soda in smaller applications, about 50 pounds to the acre, is also very desirable as a summer application, as it serves to keep the lawn a bright green during a period when nitrification in the soil is very low, and prevents the parched appearance of the lawn during the summer months.

### LIMING.

If a surface application of lime is necessary, it is applied in the fall by scattering broadcast well-slaked lime at the rate of 500 to 1,000 pounds to the acre. Lime is especially beneficial on some soils, making them better suited to bluegrass and other desirable grasses, as well as white clover.

## RELATION OF WALKS AND DRIVES TO THE GREENSWARD.

While walks and drives should always be direct, they should be made to conform to the contour of the land instead of being made straight. On small areas, however, there is no advantage in curved walks. The straight line is the shortest distance between two points and in general furnishes the most appropriate approach to the house or outbuilding. The relation of the greensward to the walk or drive, however, is not that of directness but that of beauty.

All walks and drives in private places or in parks should be sufficiently below the level of the greensward to be hidden from the observer standing at right angles to the walk and a few hundred feet from it; that is, to such an observer it should present an unbroken, continuous effect. By this means the apparent extent of the area can be greatly increased, while, if the walk or drive should be elevated above the level of the greensward, the lawn would have the appearance of being cut up into small patches or plats—a very undesirable condition in the lawn of a park or private place.

The edges of the greensward should be carried to the edges of the gutter or walk with a gentle roll rather than with an abrupt bank. Banks are not desirable. Gentle, sloping surfaces are more easily kept in position, more easily grassed, and present a more pleasing appearance than abrupt banks. The gentle roll, when properly made, will serve the same purpose in edging the walk or drive as the abrupt bank.

In general, walks and drives through areas in which lawns predominate should be made of harmonizing material; that is, gravel or dirt roads are to be preferred to any form of pavement. The walks if made of gravel are more in keeping with the general character and aspect of the place than if made of asphalt or either natural or artificial stone. Where there is a great deal of traffic, which is not usually permitted in parks, some form of pavement or permanent walk other than that afforded by gravel must be used. The color of the walk and drive should not present a striking contrast to the greensward. Subdued colors are to be preferred to bright, glistening material for the construction of walks and drives.

## RELATION OF TREES AND SHRUBS TO A LAWN.

As has already been suggested, trees and shrubs upon small places should occupy subordinate positions. They should not be scattered promiscuously over the surface of the lawn, but should be used in groups about the border of the grounds, in the bays of walks and drives, and about the foundation of the architectural features of the place. Street trees of necessity must be planted in rows, but all other adornments in the form of trees and shrubs should be used in a free rather than in a formal fashion. Sheared hedges of box or privet along the front of a place or upon the borders of the walks and drives are seldom or never desirable features, unless the whole treatment of the place is formal. A specimen tree or shrub if properly located upon the lawn so as to break up the barrenness of a corner or to limit the vision in any direction is an appropriate object. Oftentimes trees and shrubs can be used to good effect in the immediate vicinity of buildings for softening or relieving staring architectural lines. Of late many plans for the decoration of gardens and grounds have suggested the use of trees and shrubs more in the manner of paling fences and statuary than as living objects carrying individuality. The aim should be to preserve the natural lines and characteristics peculiar to each species of plant used in any decorative scheme rather than to shape the plant into artificial forms. It is the height of folly to prune evergreens in the form of Chinese vases, animals, and articles of furniture. This type of distorture is becoming altogether too prevalent in the mad rush toward the supposed return to nature. Let us not forget that in the treatment of our places that nature unadorned is adorned most, and that the normal, naturally pruned tree or shrub is much more beautiful than the one which has been trimmed into mimicry of some artificial object.

Trees and shrubs should be used to conceal unsightly objects in the foreground or in the background, to give surprises, and to give the feeling of discovery in passing from one portion of a large estate to another, and for the purpose of increasing the apparent length in drives which double back upon themselves in parks and pleasure grounds. Evergreens which are used upon the lawn should have the lower branches preserved so as to produce the effect of arising from the ground not merely by a single stem but as a mass. Shrubbery groups should also be chosen so as to carry the foliage of the group to the greensward rather than to present a considerable extent of bare stalk between the foliage of the shrub and the lawn.

As was stated at the outset, the lawn is the canvass upon which the architectural and landscape effects are to be produced, and all artificial structures as well as plantations should be made to harmonize with the contour of the ground and with the general scheme of the place so as to produce a harmonious and pleasing picture.

## BOTANICAL NAMES OF GRASSES REFERRED TO IN THIS BULLETIN.

| | |
|---|---|
| Bermuda grass | *Capriola dactylon* (L.) Kuntze. |
| Buffalo grass | *Bulbilis dactyloides* (Nutt.) Raf. |
| Canadian bluegrass | *Poa compressa* L. |
| Carpet grass | *Paspalum compressum* (Sw.) Nees. |
| Charleston grass (*see* St. Augustine grass). | |
| Crab grass | *Syntherisma sanguinalis* (L.) Dulac. |
| Creeping bent grass | *Agrostis stolonifera* L. |
| Herds grass (*see* Redtop). | |
| Italian rye grass | *Lolium multiflorum* Lam. |
| June grass (*see* Kentucky bluegrass). | |
| Kentucky bluegrass | *Poa pratensis* L. |
| Knot grass | *Paspalum distichum* L. |
| Large water grass | *Paspalum dilatatum* Poir. |
| Mesquite grass | *Bouteloua*. |
| Mission grass (*see* St. Augustine grass). | |
| Perennial rye grass | *Lolium perenne* L. |
| Red fescue | *Festuca rubra* L. |
| Redtop | *Agrostis alba* L. |
| Rhode Island bent grass | *Agrostis canina* L. |
| Rough-stalked meadow grass | *Poa trivialis* L. |
| Seacoast bent grass | *Agrostis alba maritima* (Lam.) Meyer. |
| Sheep fescue | *Festuca ovina* L. |
| St. Augustine grass | *Stenotaphrum dimidiatum* (L.) Brong. |
| Sweet vernal grass | *Anthoxanthum odoratum* L. |
| Wood meadow grass | *Poa nemoralis* L. |

## BOTANICAL NAMES OF PLANTS OTHER THAN GRASSES REFERRED TO IN THIS BULLETIN.

| | |
|---|---|
| Creeping Jenny (*see* Gill-over-the-ground). | |
| Drooping golden bell | *Forsythia suspensa* Vahl. |
| English ivy | *Hedera helix* L. |
| Gill-over-the-ground | *Glecoma hederacea* L. |
| Hall's honeysuckle (a form of Japanese honeysuckle). | |
| Japanese honeysuckle | *Lonicera japonica* Thunb. |
| Japanese mountain spurge | *Pachysandra terminalis* Sieb. & Zucc. |
| Matrimony vine | *Lycium chinense* Mill. |
| Moneywort | *Lysimachia nummularia* L. |
| Myrtle | *Vinca minor* L. |
| Virginia creeper | *Psedera quinquefolia* (L.) Greene. |
| White clover | *Trifolium repens* L. |